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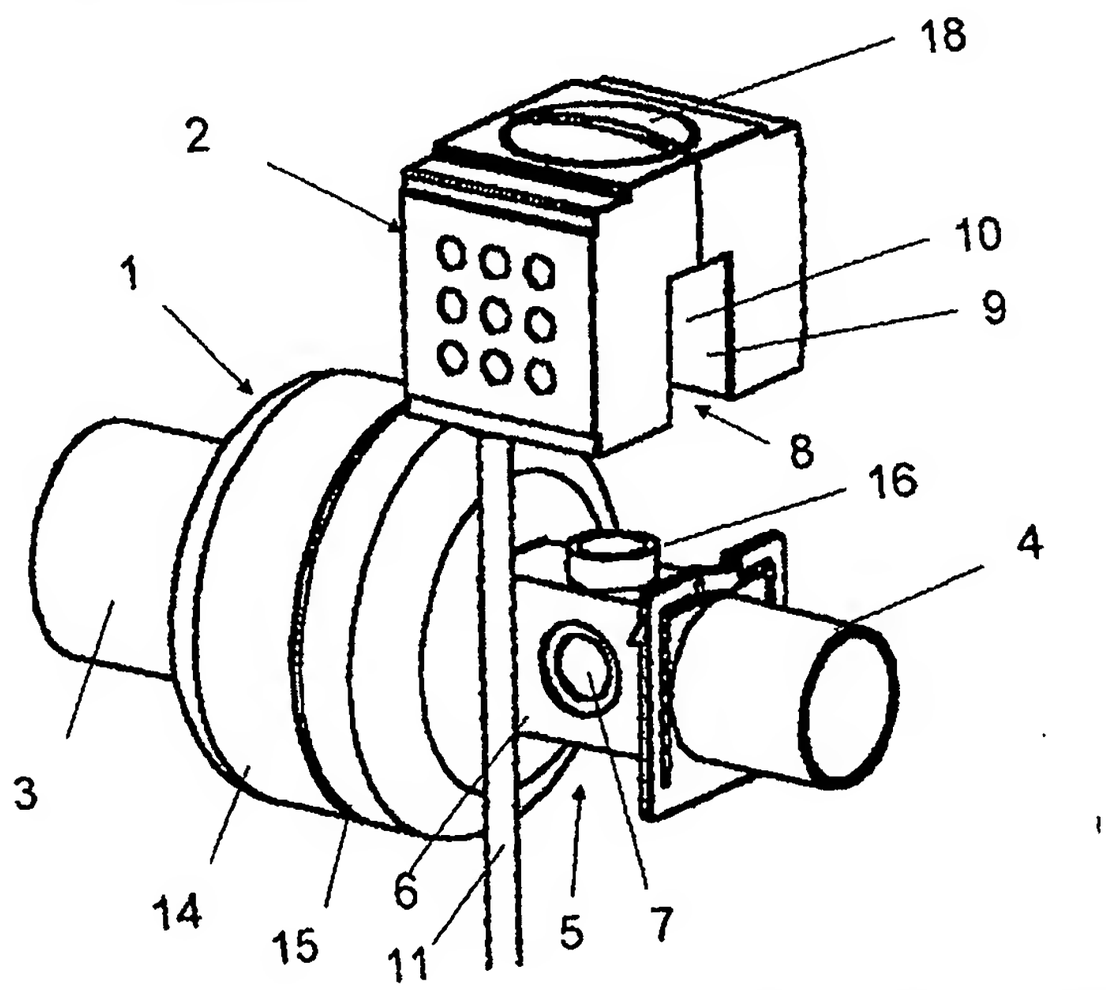
(54) Title: DEVICE AT QUANTITATIVE ANALYSIS OF RESPIRATORY GASES



(57) Abstract: The invention relates to an arrangement for the quantitative analysis of respiratory gases to and from a patient connected to a respirator for breathing assistance, wherein the arrrangement includes an adapter (1) having connectors (4) for connection to a respirator or the like, and connectors (3) for connection to a hose (13) leading to the patient. According to the invention a connection for a measuring head (2) for a gas analyser is provided in the adapter (1) between the respirator connector (4) and the connectors (3) for connecting said hoses to the patient, wherein the measuring head connection includes two windows (7) through which rays of light from the measuring head (2) can pass; and in that the adapter (1) also includes a connection (16) for a fuel cell (18) for measuring the oxygen gas content of the respiration gases.

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Device at quantitative analysis of respiratory gases

The present invention relates to an arrangement pertaining to the quantitative analysis of respiratory gases to and from a patient connected to a respirator for breathing assistance.

With regard to gas analysis carried out in connection with respiratory care, a distinction is made between two principle types of gas analysers, i.e. between lateral flow measuring analysers and main flow measuring analysers. The lateral flow measuring analysers take a minor sample flow from the respiratory circuit of a patient to an adjacent instrument in which the actual gas analysis takes place, whereas the main flow measuring analysers calculate the gas concentrations directly in the respiratory circuit of the patient. The main flow measuring analyser is normally placed as close as possible to the patient's mouth or trachea, for reasons of accuracy.

The main flow measuring analysers can be made less expensive, smaller, more energy-lean and more responsive than the lateral flow measuring analysers, since the need for sample flow handling (pumps, hoses, etc.) is obviated. Consequently, the main flow measuring gas analysers are preferred over the lateral flow measuring analysers.

Various requirements for gas analyses exist in health care. For example, it is sufficient to monitor breathing of a patient with a simple carbon dioxide analysis in the case of emergency care, whereas it is often desired to measure and monitor a greater number of patient gases, such as carbon dioxide, oxygen gas, nitrous oxide and one or more of the

anaesthesia agents Halothan, Enfluran, Isofluran, Sevofluran and Desfluran in the case of patient anaesthesia.

For reasons of a technical nature, it has been difficult to develop main flow measuring patient-gas analysers other than for carbon dioxide. Although such analysers have found a broad use spectrum in emergency care in particular, the use of lateral flow measuring analysers has been referred to in other care aspects, such as intensive care and anaesthesia, for instance, due to the technical problems that occur.

Respiratory gases can be analysed in accordance with different measuring principles. The most common method of gas analysis, however, is through the medium of non-dispersive spectroscopy. This measuring principle is based on the fact that many gases absorb infrared energy at a wavelength specific for the substance concerned. Main flow measuring gas analysers based on non-dispersive spectroscopy measure light absorption at specific wavelengths directly in the patient's respiratory circuit. An earlier known design of one such gas analyser is described in WO91/18279 A1, for instance. In the case of this gas analyser, a broadband infrared light beam is allowed to pass through the patient's respiratory circuit. The light beam is then divided by a beam splitter into two beams, which are registered by two separate detectors provided with optical bandpass filters having mutually different centre wavelengths. One detector is used to calculate the intensity of the light beam at the absorption wavelength of the analysis substance, whereas the other detector is used to calculate a measurement of the reference intensity of the light beam at a wavelength different from the absorption wavelength of the analysis substance. This type of gas analyser is well suited for the analysis of individual gases,

such as carbon dioxide, for instance. However, intensity losses in the beam splitter and the size of the beam splitter make this type of analyser unsuitable for the multigas analysis based on main flow.

Unfortunately, oxygen gas exhibits no marked absorption within the infrared range and, in respect of oxygen gas analysis, there are normally used fuel cells or analysers that utilise the paramagnetic properties of oxygen gas. These latter solutions are highly shock sensitive, which makes them unsuitable for main flow measuring analysis.

Fuel cells are comprised of a gold cathode and a lead cathode surrounded by an electrolyte protected by a membrane through which oxygen-gas diffuses into the cell. The current generated by the cell is directly proportional to the partial pressure of the oxygen gas. The response time of the cell is dependent on the design of the membrane and its thickness, and also to the extent to which the gas yield is permitted to take place nearest the membrane. However, response times are normally in the magnitude of from one to ten seconds. Response times of such long duration have made it difficult to use fuel cells for registration of oxygen gas that is dissolved during main flow measuring gas analysis.

Accordingly, the object of the present invention is to provide a novel arrangement which enables respiratory gases to be measured and analysed effectively in one and the same measuring sequence by non-dispersive spectroscopy and, at the same time, also to measure and analyse oxygen gas.

This object is achieved with a gas analyser that includes an adapter which has connectors for connection to a respirator

or the like, and connectors for connecting a hose that leads to the patient, wherein, in accordance with the invention, the adapter includes a measuring head connection between the respirator connector and the connectors for connection of the patient hoses, wherein the measuring head connection includes two windows through which light rays from the measuring head can pass, and wherein the adapter also includes a connection for a fuel cell for oxygen gas analysis.

According to particular embodiments of the inventive gas analyser, the analyser is designed so that it can be used to moisten the respiratory gases, or is provided with a bacteria filter for preventing analyser contamination.

The invention will now be described in more detail with reference to a non-limiting embodiment thereof and also with reference to the accompanying drawings, in which **Fig. 1** is a schematic perspective view of an inventive arrangement with associated measuring head; **Fig. 2** is a schematic illustration of a patient connected to a respirator with the aid of the inventive arrangement; and **Fig. 3** is a schematic sectional view of an adapter according to the invention.

Thus, Fig. 1 shows a gas analyser constructed in accordance with the invention and comprising an adapter 1 and an associated measuring head 2. The adapter 1 has essentially the form of an elongate tube made, for instance, of a plastic material. The adapter 1 has at one end a connector 3 for a hose that leads to the patient. The other end of the adapter carries a connector 4 for a respirator or the like. Located between the two connectors 3, 4 on the adapter 1 is a central portion 5 which is designed to accommodate the measuring head. To this end, the central portion 5 includes two mutu-

ally opposing planar surfaces 6, each of which includes a respective window 7 comprised of transparent film.

The measuring head 2 includes a central aperture 8 which extends from one side of the measuring head so as to enable the measuring head to be pushed over the central portion 5 of the adapter. To this end, the aperture is provided with two mutually opposing, generally planar and mutual parallel surfaces 9 that face inwardly towards the aperture. Respective planar surfaces 9 on the measuring head 2 are provided with a light transmitter and a light receiver 10 for transmitting and receiving infrared light respectively. The light transmitter and light receiver are connected by a signal cable 11 to a measuring instrument that analyses the signals obtained from the receiver. The planar surfaces 9 on the measuring head 2 and the planar sides 6 of the central portion 5 of the adapter 1 are mutually designed and dimensioned so that the measuring instrument 2 will be positioned precisely when mounted on the adapter 1, so that light emitted by the light transmitter 10 is able to pass through the central portion 5 of the adapter and through its window 7, and reach the light receiver without being influenced by anything other than that which passes through the interior of the central portion 5 of the adapter.

As mentioned above, a fuel cell is provided in the central portion 5 of the adapter for measuring the oxygen gas content of the expiration air. To this end, a connection 16 to which such a fuel cell 18 can be connected is provided in one side wall of the central portion 5 that contains no window 7.

Fig. 2 illustrates a patient connected to a respirator with the aid of the inventive arrangement. It will be seen that

respirator hoses 12 are connected to the adapter connector 4 and that a patient hose 13 is connected to the patient from the second adapter connector 3.

Fig. 3 shows how a fuel cell 18 provided with an O-ring seal 19 can be fastened to the central portion 5 of an adapter. Also shown in the figure is the internal channel 20 of the central portion 5 through which the respiratory gases flow to and from the patient. The internal channel may conveniently be provided with a flow directing means 21 for guiding part of the respiratory gases towards the fuel cell 18 and thereby reduce the step response of the oxygen gas measuring process.

As will be seen from Fig. 1, the adapter 1 also includes a passive respiratory gas humidifier or breath moistener 14 between its central portion 5 containing the planar sides 6 for receiving the measuring head and the windows 7 on the planar surfaces, and the connection 3 for connecting the adapter to the patient hose. This passive humidifier may be a so-called HCH, Hygroscopic Condensation Humidifier, or an HME, Heat Moisture Exchanger, of the types generally used in respiratory care. These devices moisturise the respiratory gases by capturing moisture, and to some extent also heat, as the patient breathes, and then return the moisture to the inspiration air as the patient breathes in. Because the passive respiratory gas humidifier 14 is situated between the patient hose connection 3 and the central portion 5 of the adapter, the expiration gases will be dehumidified when entering the central portion, where the windows 7 are situated, therewith preventing the occurrence of condensation on said windows and also enabling the expiration gas flowing through said central portion 5 to be analysed in a known manner with the aid of the measuring head 2. The passive humidifier 14 is

placed in the adapter in the form of a piece of wadding or a roll impregnated with a hygroscopic salt and inserted through the open end of the connector 3.

In addition to the humidifier 14, the adapter 1 may also include bacteria filter 15 situated between the humidifier 14 and the central portion 5. The filter 15 enables bacteria to be removed from the expiration gas, so that, e.g., the oxygen gas concentration can be measured with the aid of a fuel cell without danger of cross contamination between different patients.

As an alternative to the bacterial filter in the main flow of the adapter 1 as described above, the connection 16 may be provided with a separate bacterial filter 17, for instance in the form of a membrane, as a protection against cross-contamination.

As a further prevention against cross-contamination, a bacteria filter may be arranged in both the main flow, between the patient connection 3 and the central portion 5 of the adapter, and also in the fuel cell connection 16.

The inventive adapter may conveniently be injection-moulded from plastic material and therewith be produced for one-time use at a relatively low cost. The measuring head casing may also be produced from a plastic material although not for one-time use, since the measuring head is used together with the measuring instrument and is not affected or contaminated by the respiratory gases.

CLAIMS

1. An arrangement for the quantitative analysis of respiratory gases to and from a patient connected to a respirator for breathing assistance, wherein the arrangement includes an adapter (1) having connectors (4) for connection to a respirator or the like, and connectors (3) for connection to a hose (13) leading to the patient, **characterised** in that a connection for a measuring head (2) for a gas analyser is provided in the adapter (1) between the respirator connector (4) and the connectors (3) for connecting said hoses to the patient, wherein the measuring head connection includes two windows (7) through which rays of light from the measuring head (2) can pass; and in that the adapter (1) also includes a connection (16) for a fuel cell (18) for measuring the oxygen gas content of the respiration gases.

2. An arrangement according to Claim 1, **characterised** in that the measuring head connection includes two mutually opposing planar sides (6) in which the windows (7) are located; and in that the measuring head (2) includes a central aperture (8) that has two mutually facing planar surfaces (9) for sealingly mounting the measuring head over the planar sides (6) of said connection.

3. An arrangement according to Claim 1 or 2, **characterised** in that the adapter (1) includes a flow directing means (21) for guiding part of the respiratory gases towards the fuel cell (18).

4. An arrangement according to any one of the preceding Claims, **characterised** in that the adapter includes a passive respiratory gas humidifier (14) between the respirator con-

nector (4) and the connectors for connecting the hoses to said patient.

5. An arrangement according to any one of the preceding Claims, **characterised** in that the adapter includes a bacteria filter (15; 17) for protecting the fuel cell (18) from bacteria present in the respiratory gases.

6. An arrangement according to Claim 5, **characterised** in that the bacteria filter (15) is located in the adapter (1) between the connectors (3) for connecting said hoses to the patient and the measuring head connection (2)..

7. An arrangement according to Claim 5, **characterised** in that the bacteria filter (17) is located at the fuel cell connection (16).

8. An arrangement according to any one of the preceding Claims, **characterised** in that the adapter (1) is injection moulded from a plastic material.

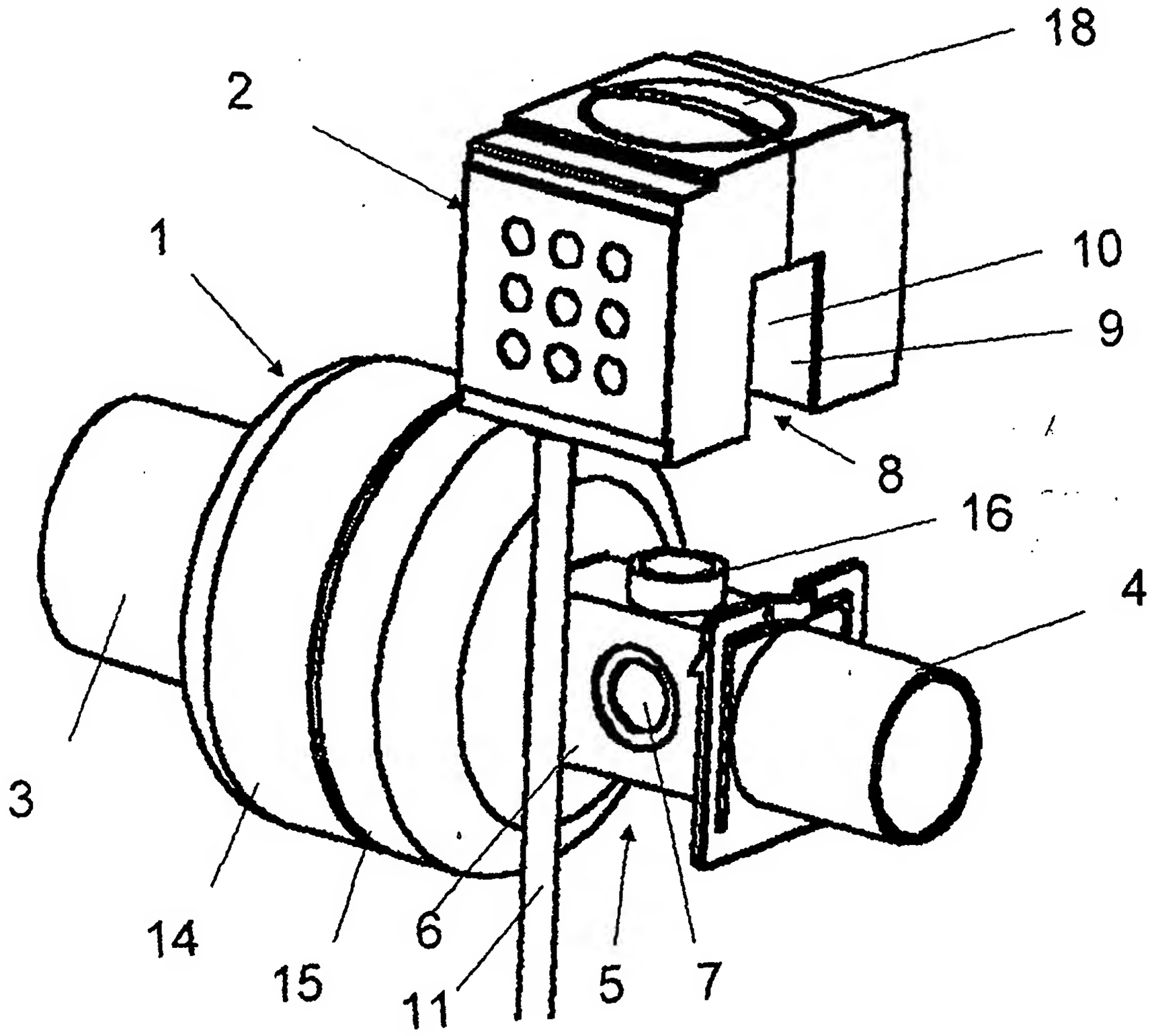

Fig. 1

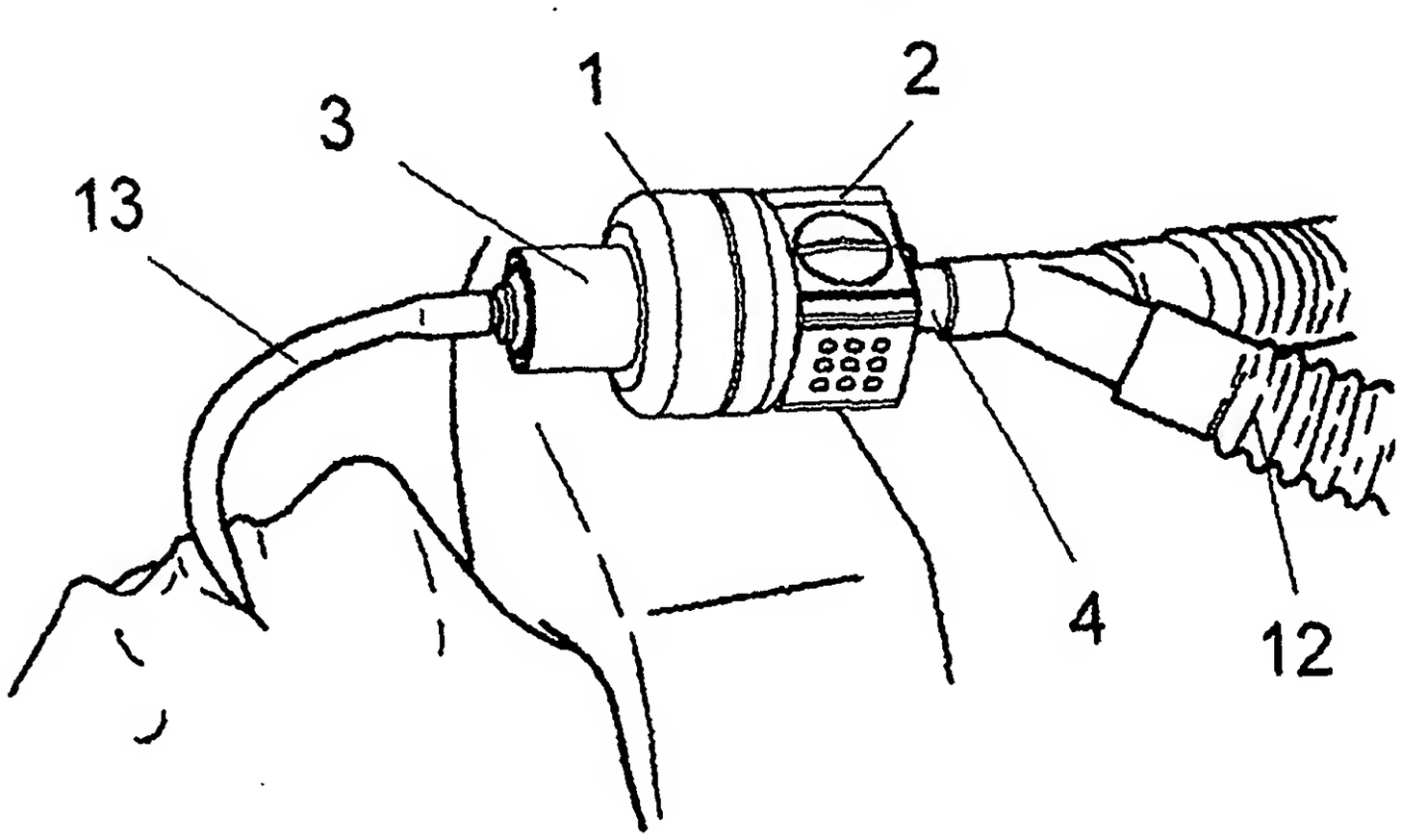

Fig. 2

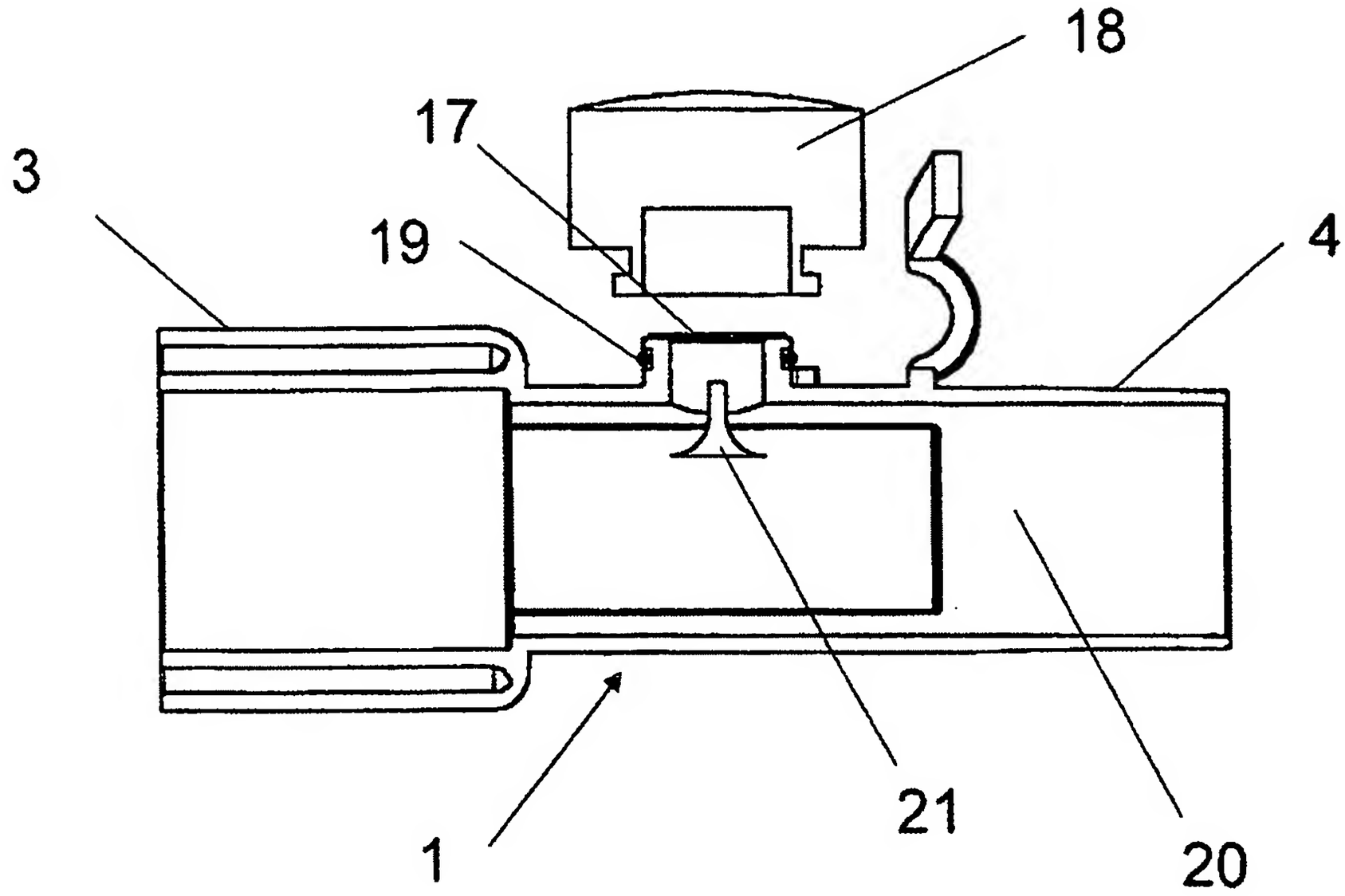

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01528

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A61B 5/08, A61M 16/00, G01N 33/497
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A61B, A61M, G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2287655 A (MICRO MEDICAL LIMITED), 27 Sept 1995 (27.09.95), page 5, line 11 - page 7, line 2, figure 1, abstract --	1-8
A	US 5701888 A (ROBERT Q. THAM ET AL), 30 December 1997 (30.12.97), column 3, line 62 - column 4, line 12, figure 1, abstract --	1-8
A	US 6039697 A (THOMAS A. WILKE ET AL), 21 March 2000 (21.03.00), column 12, line 38 - line 63, figure 3A --	1-8

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 November 2002	04 -12- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulrika Westman/mj Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01528

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9846277 A2 (OHMEDA INC.), 22 October 1998 (22.10.98), abstract -- --------	1-8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/02

International application No.
PCT/SE 02/01528

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2287655 A	27/09/95	GB 9404804 D	00/00/00
US 5701888 A	30/12/97	EP 0823259 A	11/02/98
US 6039697 A	21/03/00	NONE	
WO 9846277 A2	22/10/98	AU 6872698 A	11/11/98